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quently verified visually, and observed at different observatories. The second was discovered at the same observatory by Mr. CODDINGTON, with the same instrument, in July, 1898.

There are very few departments of astronomy where photography has not taken a prominent, if not a commanding, position. It is probable, however, that it will never take the place of the micrometer in the observation of close double stars and similar objects, and in this direction the micrometer of BURNHAM will perhaps never be displaced. The photography of the surface features of the planets is in an almost hopeless condition at present, yet much can be expected in this direction when an increased sensitiveness of the plates has been secured.

It is impossible within the limits of this address to give more than a general, and at best incomplete, sketch of the rise and progress of photography in the various lines of astronomical research. To those who have kept pace with these rapid strides in the last twenty years, this brief history will seem imperfect, and perhaps of little interest. Many applications of the photographic art, and many valuable results have necessarily been omitted. But few of the names of those prominently identified with this subject have been mentioned, and but little of their work even alluded to. A volume of no small dimensions would be necessary to give a complete history of the development of photography in the many directions in which it has been applied to astronomy. The time to do this has not yet come. Progress has been so rapid and far-reaching that its history, however complete and exhaustive, a year later requires to be rewritten; and there is no reason for supposing that the end, or even the beginning of the end, has been reached. With new materials, and new methods, and new workers, who will profit by the experience and results gained by those who have in our time accomplished so much, we may expect for the new century far greater results than those briefly recorded here.

THE SURFACE OF THE SUN.

BY ROSE O'HALLORAN.

The following data, obtained from records of the condition of the solar surface as observed with a four-inch telescope, seemed to indicate the near approach of the sun-spot minimum.

Between October 17, 1897, and March 18, 1898, the Sun was observed on one hundred and twenty-six days, during which thirty spots appeared on the disc, three of which were of considerable size, having nuclei that measured from 10,000 to 20,000 miles length.

The various durations of these thirty markings caused the Sun to present a spotted appearance on ninety-eight days, which were interspersed with intervals of unspottedness amounting to twenty-eight days, the longest interval being fourteen days, in the latter half of October, 1897. During a succeeding period of equal length, dating from March 18th to August 16th, in the present year, observations were taken on one hundred and thirteen days, seventy-three of which revealed a state of activity due to the coming and duration of nineteen spots. In three cases the nuclei measured about 10,000 miles, and a nucleus double that length was conspicuous in the beginning of August. On forty



SUN-SPOT, SEPTEMBER 9TH, NOON.

days the disc was an unbroken white tract, sixteen consecutive days of unspottedness having occurred in April, while the remainder were distributed in much smaller divisions. In these comparative data the term *spot* is used not only to denote single markings far apart from others, but also groups in which the components are sufficiently close to be regarded as the result of one disturbance. The cloudy days are indeterminable factors; but as in this Californian climate the Sun is rarely obscured for many consecutive days, it is not probable that cloudiness changes the result materially, unless there be only a trifling difference in the compared data.

Three small spots appeared between August 16th and September 2d, and on the morning of the latter date the symmetry of the southeast limb was noticeably impaired by the advent of an enormous spot, about 51,000 miles in length. On September 4th,

two almost imperceptible markings appeared adjacent to its eastern side, and on the 7th commenced to develop, forming large penumbral tracts with several small nuclei. The nearest spread into connection with the large spot, and the group then extended over an area 140,000 miles long when on the center of the disc. Having observed the Sun for the past eight years, and preserved drawings of the principal spots, comparison shows that during



SUN-SPOT,
SEPTEMBER 3D,
2:30 P. M.

that period it has been equaled only by those of February, 1892, and August, 1893, in compactness and extent. Though it seemed lower on the disc, owing to the position of the plane of the solar equator on those days, measurement placed it between south heliographic latitude 8° and 15° .

It may have been the development of a very small spot that commenced its existence towards the center of the disc on August 11th within the same latitude; otherwise, it cannot be traced as the continuance of any previous disturbance, and must have formed on the unseen surface in the latter half of August.

The final chapter in the career of this unseasonable solar storm is its return in due time on September 28th in the form of two small spots with dark nuclei. On the 30th one of much larger size followed them, but it could not be classed as a remnant of the giant storm, though its position was suggestive of a common origin.

SAN FRANCISCO, October 13, 1898.

THE TEMPERATURE OF THE SUN. II.

BY PROF. DR. J. SCHEINER.

[Translated from the German in *Himmel und Erde*, by FREDERICK H. SEARES.]

It is a fundamental law of all exact investigation that the investigator should not be satisfied with the derivation of an important result in the most direct way alone, but that he should strive by other means, or by indirect methods, which, under certain circumstances may be very complicated, to arrive at the same result. Only when this has been done, where the same end has been reached by following different lines of thought, can the result be said to have been established. Frequently it happens that, in consequence of the nature of the problem, the methods